Session 10

Lectures:

ATMOSPHERIC EFFECTS ON LASER WEAPONRY.

A. Zilberman and N. S. Kopeika

Ben-Gurion University of the Negev

Electrical and Computer Engineering Dept.

POB 653, Beer-Sheva 84105, Israel

kopeika@ee.bgu.ac.il;

arkadiz@ee.bgu.ac.il

As a laser beam propagates through the atmosphere, it will experience random deflections due to turbulence. As a result, the beam spot at the target plane will wander randomly and increase in diameter (beam widening). These effects affect various types of electro-optical and laser-based systems.

The beam wander is important for beam pointing considerations, while the short-time widening is important for pulse propagation problems and high-energy laser systems. In particular, the wander and widening of a laser beam reduces its irradiance at the target plane and the precision of pointing at a target in military applications.

Atmospheric mixtures (aerosol, dust, fog, etc.) that scatter and absorb electromagnetic radiation are another source that reduces performance of laser-based systems operating through the atmosphere. Atmospheric mixtures comprise a dispersed system of small solid and liquid particles suspended in air. Their size range covers more than five orders of magnitude, from ten nanometers to several hundred micrometers. This particle size range is very effective for scattering of radiation at ultraviolet (UV), visible, and infrared (IR) wavelengths. Multiple scattering gives rise, together with turbulence effects, to beam widening and induces loss of beam intensity (attenuation) after it has traversed the scatterers and reduces beam irradiance at the target.

Understanding atmospheric turbulence and scattering statistics, therefore, can provide ways to correct for degradations of optical systems operating through the atmosphere and to predict their performance.

On the basis of LIDAR measurements and model calculations the influence of turbulence and atmospheric scatterers on laser beam propagation is estimated for different scenarios of vertical and slant-path propagation.

RETRIEVING SCATTERING DEPTH PROFILES FROM OCEAN LIDAR WAVEFORMS

E.P. Zege, I.L. Katsev, and A.S. Prikhach
B. I. Stepanov Institute of Physics, National Academy of Science of Belarus,
Nezavisimosti Ave. 68, Minsk, 220072, Belarus; E-mail: eleonor@zege.bas-net.by

As known, up to now ocean lidar sounding cannot be qualified as a quantitative exploring method for seawaters. In spite of lidar waveforms are intimately related to the depth profiles of Inherent Optical Properties (IOP) of seawaters, the reliable inversion techniques have not been proposed yet. One of the reasons is the decisive contribution of multiple scattering to the lidar return in the ocean lidars. The lack of an adequate theory of the lidar return signal that includes multiple scattering is one of the main obstacles preventing ocean lidar sounding from giving IOP. Such a theory as well as quasi-real time computer modeling of the ocean lidar performance was developed by authors recently. These approaches jointly make an excellent tool for developing and testing various retrieval techniques.

In this paper we present a new general analytical inversion of the lidar equation with multiple scattering in the common case, derived without any *a priory* suggestion. This new inversion of the lidar equation includes all known solutions as particular cases and serves as a theoretical base for the newly developed techniques to retrieve the IOP profiles from measured lidar waveforms. The developed fast simulation is a key to implementation of these procedures. The suggested iterative procedures require multiple computations of lidar return with different IOP profiles and in this process our fast modeling looks indispensable.

We present also a new special tool, software "INVERTER", for development, verification and refinement of various retrieval techniques. The main component of this software is the previously developed program to simulate the waveforms in the ocean lidars. The modeling includes noise of different origin, particularly, shot noise, analogous-digital converter (ADC) noise, and constant background, which limit the measured depth range. The various iterative retrieval algorithms for different lidar systems are discussed. We have performed study of stability of the retrieval procedure and its sensitivity to the accuracy of *a priory* information. Particularly, it is shown that the lack of knowledge of the phase function does not lead to the noticeable retrieval errors. The performed retrieval simulations were successful and showed an excellent coincidence of the retrieved profiles of seawater IOP with the initial ones (the sea truth).

ON A POLARIZATION EFFECT FOR MULTIPLE SCATTERING BY NON-SPHERICAL PARTICLES

P.Bruscaglioni. S.Del Bianco, S.Lolli. University of Florence.
Via Sansone 1. 50019 Sesto Fiorentino. Italy.
piero.bruscaglioni@unifi.it

If the scatterers are not of spherical shape, or their symmetry axes are not distributed isotropically in space or symmetrically about the propagation direction, propagation characteristics such as extinction depend on radiation polarization.. Moreover, polarization, and particle cross section generally change along the propagation direction. Thus there can be some difficulty for defining a linear extinction coefficient even for a medium with uniform density of non-spherical scatterers. However, it can be shown that, there are always two particular types of polarization for which polarization is maintained during propagation in the beam direction. We call these as "Polarization Modes".

The formal procedure to obtain the Modes can be found in the literature (see for instance reference **1**) and can be obtained from the 16 elements of the Mueller matrix. The Stokes vector elements must change proportionally during radiation propagation.

We can show that this point can be more simply dealt with by considering the four elements of the Jones matrix. (**J**). The extinction coefficient of the medium and the polarization modes will be related to the four elements of **J**

Some checks will be presented regarding the Polarization Modes in cases of small ellipsoids with different space distribution of their symmetry axes, and in the case of small spheres with chiral properties.

Since multiple scattering in turbid media are dealt with by making reference to the Radiative Transfer scheme, and Monte Carlo methods are based on considering the linear extinction coefficient of the medium, it can be opportune to consider this effect, and to take into consideration the change of polarization of the propagating radiation, unless the Modes are involved.

Possible modifications are suggested to the conventional Monte Carlo procedure

Acknowledgment. The study is supported through the EU INTAS Project 05-1000000-8024

1. L.Tsang, J.A.Kong, R.T.Shin. Theory of microwave remote sensing. Wiley New York.1988. Sect.3.8.

Polarized CCD lidar returns from broken clouds

Ulrich G. Oppel[a], Sergei M. Prigarin[b], and Martin Wengenmayer[a]

[a)] Institute of Mathematics, Ludwig-Maximilian University, Munich
[b)]Institute of Computational Mathematics and Mathematical Geophysics, Novosibirsk
Ulrich.Oppel@mathematik.uni-muenchen.de

For more than 30 years lidars are used for remote sensinsing of the atmosphere. The emitter of a lidar transmits a collimated laser beam into the atmosphere, some of the laser light is reflected to the receiver of the lidar by the particles and molecules. If the particle density is not so high, the evaluation of the lidar return may be based on the classical lidar equation which describes the single scattering contribution to the lidar return only. However, returns from dense clouds of ground-based lidars or returns of space-based lidars contain considerable contributions of high orders of multiple scattering. Therefore the evaluation of such lidar returns must be based on a more complex theory, e.g. on stochastic models of multiple scattering or on radiative transport theory. But such multiple scattering contributions to the lidar return do not only complicate the evaluation of the returns, they also contain additional valuable information about the scattering particles. To make use of it, multi-channel lidars with various fields of view and polarization and CCD lidars have been constructed. To support the design of such new lidars, several groups of scientists developed appropriate theories and tools for the simulation and evaluation of multiply scattered lidar returns. One of the first groups was founded in Jerusalem in 1987, the MUSCLE group.

The methods for the description, simulation, and evaluation of mutilply scattered lidar returns where gradually improved. A development which was supported by co-operation and by progress of computer hardware. The progress in opto-electronics made possible the construction of lidars with charged coupled devices which allow for taking time resolved two-dimensional pictures of the diffusion of the lidar beam in a cloud, promissing additional gain of information from such CCD lidar returns.

First, we introduce some methods for the simulation of fields of broken clouds and screens of aerosols which are based on the theory of point processes and cloud statistics, on Gaussian processes, and on graphical procedures. We consider clouds and screens with varying density and composition of aerosols like water droplets with changing droplet size distribution and ice and dust clouds consistent of various types of particles.

Then we discuss the single scattering of polarized light by various types of particles and simulate lidar returns and CCD lidar returns from various types of broken clouds. We compare the two kinds of lidar returns and show the superior capability of CCD lidar returns for the distinction of various types of aerosol clouds and screens. Such simulations can be done easily with the new version of our program PBS4. It is based on our stochastic model of corpuscular multiple scattering of polarized light which is a partially deterministic Markovian jump process and which is equivalent to an appropriate version of the radiative transport equation for polarized light.

SCATTERING MATRICES FOR PREFERABLY ORIENTED ICE CRYSTAL PARTICLES

A.G. Borovoi[1], A.V. Burnashov[1], and Ariel Cohen[2]

[1]Institute of Atmospheric Optics, Rus. Acad. Sci., pr. Akademicheskii 1, 634055 Tomsk, borovoi@iao.ruRussia, e-mail:
[2]Hebrew University of Jerusalem, Safra Campus 1, 91904, Jerusalem, Israel

Cirrus clouds consisting mainly of ice crystal particles cover in average 20-30% of Earth's surface, and they essentially impact on radiation budget of the Earth and, hence, on the global climate. Therefore, optical properties of cirrus clouds are needed for up-to-date numerical models of long-term weather forecasting and global climate changes. The optical properties of ice crystal particles have been calculating for recent 20-30 years by a lot of authors (e.g., K.N. Liou., P. Yang, A. Macke, K. Muinonen). However, the crystals often reveal a tendency to be oriented in the horizontal plane because of aerodynamic laws. Such preferable orientation is readily justified by numerous halo phenomena studied and classified for centuries. A lot of halos and arcs watched in the sky are qualitatively explained by just the horizontal particle orientation. As for quantitative data concerning the problem of light scattering by ice crystal particles with preferably horizontal orientation, they are rather poor. In this contribution, we work out a quantitative model of the scattering matrix for hexagonal ice plates and columns that are preferably oriented near the horizontal plane.

Since the ice crystals are much larger that the incident wavelength, the scattering problem is conventionally considered in the geometric optics approximation. This approximation leads mathematically to a number of specific singularities that are watched as sharp peaks. They are the forward scattering peak, sundogs, parhelia 120º and so on. We show that angular dependence of these peaks depends scarcely of particle shapes and incident directions of light. Therefore the scattering matrices can be parameterized by only values of these peaks, i.e. by their weight coefficients. These weight coefficients have been tabulated for hexagonal plates and columns of various aspect ratios for different incidence angles.

This research is supported by the Russian Foundation for Basic Research (grants 06-05-65141 and 05-05-39014) and by the International Association for the Promotion of Cooperation with Scientists through the New Independent States of the Former Soviet Union (INTAS) under the grant 05-1000008-8024.

Bi-static Lidar Sounding of Layered Clouds in the Arctic Troposphere and Stratosphere

CABLE - a bi-static lidar study of Layered Clouds in the Arctic Troposphere and Stratosphere

Georg Witt et al.

Abstract

The effect of atmospheric clouds and aerosol on the Earth' climate is not yet completely understood. This applies not the least to high latitudes which are most sensitive to climate changes. The proper description of the radiative forcing effect of clouds requires knowledge f the micro-physical properties of the particles such as composition, phase, size distribution and spatial orientation. Lidar sounding is widely used for assessing the cloud radiative properties. With little exception, current lidar systems restrict themselves to the back-scattering geometry. The singular scattering angle of 180° is a serious limitation to the information that can be obtained form such measurements without a wide range of assumptions. As tot he particle shape, the depolarisation of the lidar return signal makes it possible to distinguished between spherical and non-spherical scattering objects where multiple scattering is negligible.

This contribution refers to an attempt to extend the range of information of lidar data by a bi-static measurement, combining the back-scatter system with a remote receiver admitting the determibation of the polarisation state of the laser return at a scattering angle of (130° - 160°), depending on the atmospheric height. While bi-static lidar measurements of tropospheric aerosol have been reported earlier, the CABLE study concentrates on high altitude clouds such as layered cirrus and Polar Startospheric Clouds. The measurements have been carried out at the ALOMAR facility in Northern Norway (69°N;16°E) with financial support of the European Union using the ALOMAR tropospheric lidar as light source. Here we describe the technique of bi-static lidar polarisation measurement with its inherent problems and present the first successful results obtained in the October 2006 campaign.

AEROSOL TYPE DISCRIMINATION USING A MULTISPECTRAL UV-NIR-IR LIDAR

S. Egert, D. Peri
Israel Institute for Biological Research
P. O. Box 19, Ness Ziona, Israel
smadare@iibr.gov.il davidp@iibr.gov.il

During the last few years there is a growing interest in accurate monitoring of natural and anthropogenic aerosols due to their effect on public health, agriculture, and climate forcing [1]. Accurate identification of aerosol types and chemical composition may help to trace their origin using back trajectory calculations. Aerosols features such as chemical composition, size and shape manifest themselves in their spectral scattering. In order to make reliable automatic identification, thorough spectral analysis should be carried out.

In this manuscript we present back scattering measurements of several aerosol types and size distributions using an innovative LIDAR. The LIDAR transmitter is based on a single Nd:YAG laser. It produces the laser 3rd and 4th harmonies in the UV, the 1.5 μm in the near IR and up to 40 spectral lines in the 8-11 μm in the IR. The detection unit, composed of three different sensors, covers the widely separated, spectral channels. This versatile LIDAR enables very sensitive aerosol detection in the 1.5 μm channel and detailed analysis of the spectral aerosols backscattering in the IR and fluorescence from UV exposure. Spectral analysis of the fluorescence signals is performed using an eight-channels spectrometer in the UV-VIS parts of the spectrum. The LIDAR can be switched automatically between the channels based on a pre-designed detection protocol or operate at specific wavelengths within one of the spectral channels.

The LIDAR potential was demonstrated by detection and discrimination of three types of aerosols: dust, diesel fog and aerosol of silicone used as an agricultural spraying adjuvant. The capability of analyzing aerosols spectral scattering was presented previously [2] using an early version of an IR LIDAR. That LIDAR utilized a CO_2 laser as transmitter in four spectral bands, covering parts of the 9-11 μm spectral domain. Two types of dust and the oil aerosols were measured using this IR LIDAR. Though spectral differences were evident, the difficulty to discriminate between two aerosol types having a similar chemical basis (silicates in the dust and the silicone) was noted. In this presentation we demonstrate improved identification ability due to the quasi-continuous coverage of the 8-11 μm spectral range and the contribution of the two other spectral channels. Reliable identification of the three aerosol types could be made using both IR backscattering and UV fluorescence especially for the diesel fog. Due to the system wide spectral coverage it is possible to employ an automatic spectral detection and discrimination algorithm. Detailed LIDAR characteristics and their implication on the spectroscopic features used in these measurements are presented.

Literature

1. D. Rosenfeld, Y. Rudich "Desert dust suppressing precipitation: a possible desertification feedback loop", Proc. Natl. Academy of Science, USA 98 (11) 5975 (2001)
2. D. Peri, N. Shiloah, S. Egert " Dust type and pollutants identification using a Multi-spectral IR LIDAR", Proc. 22nd ILRC, ITALY, 2000

VENuS: A JOINT ISRAELI – FRENCH EARTH OBSERVATION SCIENTIFIC MISSION WITH HIGH SPATIAL AND TEMPORAL RESOLUTION CAPABILITIES

Arnon Karnieli[1], Yoram Yaniv[2], Jacob Herscovitz[3], Yoel Fixler[4]

[1] The Remote Sensing Laboratory, Jacob Blaustein Institute for Desert Research
Ben Gurion University of the Negev, Sede Boker Campus 84990, Israel.
E-mail: karnieli@bgu.ac.il, http://www.bgu.ac.il/BIDR/research/phys/remote

[2] Israel Aircraft Industries Ltd., MBT Space Division

[3] RAFAEL, Armament Development Authority Ltd

[4] Elbit Systems Electro-Optics ELOP Ltd.

ABSTRACT

Recent initiative of the Israeli Space Agency (ISA) and the French space agency (CNES) is aimed at developing, manufacturing, and operating a new Earth observing satellite called 'Vegetation and Environment monitoring New Micro-Satellite' (VENuS). The satellite is planned to be launched in early 2009, and the scientific mission should last at least two years. The general mission objectives are the provision of data for scientific studies dealing with the monitoring, analysis, and modeling of land surface functioning under the influences of environmental factors as well as human activities. The VENμS scientific mission is also aimed at demonstrating the relevance of superspectral, high spatial resolution observations combined with frequent revisit capabilities in the framework of the European Global Monitoring for Environment and Security Program (the "GMES Program").

In order to implement these goals, the mission will acquire frequent, high resolution, multispectral images of sites of interest all around the world. The satellite will fly in a near polar sun-synchronous orbit at 720 km height. The whole system will be able to be tilted up to 30 degree along and across track. This configuration will result in a 2-days revisit time, 27 km swath, a camera resolution of 5.3 m, and the capability to observe any site under a constant view angle. The system will cross the equator at around 10:30 AM.

The satellite will carry a super-spectral camera characterized by 12 narrow spectral bands ranging from 415 nm to 910 nm. The band setting was designed to characterize vegetation status, including through red-edge bands, and to estimate the aerosol optical depth and the water vapor content of the atmosphere for accurate atmospheric corrections. The spectral band setting could also prove useful for coastal areas and inland waters studies. Duplicated bands will be used for generating a digital elevation model and for retrieving top of cloud altitudes. The satellite will also carry a Technological Payload – the Israeli Hall Effect Thruster (IHET) – to validate its performance and for orbit keeping.

The data will be acquired over existing or planned experimental sites with size ranging from a few kilometers to 27 x 27 km or more. All data for a given site will be acquired with the same observation angle in order to minimize directional effects. The baseline product for these selected sites is time composite images of geometrically registered surface reflectances at 10 m resolution. Strong efforts are devoted to provide high quality data, both in term of radiometry (e.g. SNR around 100), geometry (e.g. multitemporal registration better than 3 m), and atmospheric corrected.

UV-IR COMBINED LIDAR SYSTEM

S. Fastig, Y. Ehrlich, S. Pearl, E.Naor, Y.Kraus, T. Inbar and D. Katz
Electro-Optics div., Soreq NRC, Yavne 81800, Israel
fshlomo@soreq.gov.il

Long range, combined UV-IR LIDAR system was built and tested. The system was developed to operate as a multi-wavelength DIAL in the IR (8-11 µm), dual wavelength excited LIF LIDAR in the UV, and aerosol map and track at 1.5 µm. The IR transmitter is a continuous tunable solid-state Tandem Optical Parametric Oscillator (OPO) [1]. The first OPO stage generates the 1.5 µm beam and the second OPO stage pumped by the first, generates the IR band. In the UV the transmitter generates and transmits either the 266 nm or the 355 nm wavelengths sequentially. All the outgoing laser beams are pre-aligned to ensure geometric overlap of the measured paths. Energy reference is measured for each beam on every pulse. The receiver is based on a single reflective telescope with coatings optimized for both the UV and the IR. The optical signal is routed between the different detection packages by means of a computerized optical scanner mirror. The receiver-transmitter layout is based on periscope geometry and is equipped with a large θ-φ scanner. Computer control enables fast switching between the different measurements and wavelengths, data acquisition and spatial scan as well. The system was built in a mobile trailer and was field tested. Design consideration, preliminary results of subsystems and system performance in field experiments to measure and discriminate aerosol types[2], will be presented

ELOP Multi-Spectral Spaceborne Payload for the Korean Satellite KOMPSAT-2

Dr. M. Berger[1], A. Greenbaum, T. Sprecher, L. Topaz, A. Guberman, G. Timkovski
Elbit Systems Electro-Optics Elop Ltd.

Dr. S.H. Lee[**], Dr. H.Y. Paik[***]
KARI - *Korea Aerospace Research Institute, Taejon 305-600, Korea*

el04724@elop.co.il

The Multi-Spectral Camera (MSC) is the payload of the KOMPSAT-2 satellite, developed to perform earth remote sensing. The MSC images the earth in sun-synchronous orbit by push-broom method with a swath width of 15 km at an altitude of 685 km. The Electro-Optical Sensor (EOS) is based on a Ritchie-Chrétien type two mirror telescope and a focal plane based on CCD linear detectors with up to 32 user selectable Time Delay Integration (TDI) levels. The EOS consists two imaging channels, a Panchromatic (PAN) channel (composed of 2 bands – primary & redundant), and a Multi-Spectral (MS) channel (composed of 4 spectral bands). Each band has up to 32 selectable Time Delay Integration (TDI) levels. The PAN and MS channels have 1m & 4m Ground Sample Distance (GSD) respectively (15,000 and 3750 pixels respectively). The EOS has a built- in calibration lamp for radiometric calibrations of the spectral bands in space. The output data from each spectral band was radiometrically NIST calibrated prior to launch and referenced to the lamp signal. The payload imaging data can be stored, compressed, encrypted and transmitted to Ground Station (GS) in real time. The MSC is designed to have an in-orbit operational duty cycle of 20% over the mission lifetime of 3 years. The MSC operational concept is based on pre-defined missions such as: Recorded Imaging, Direct Imaging (transmitting to GS in real-time), Playback (transmitting of pre-recorded data), Antenna Tracking, etc. A mission can be activated by issuing a mission command with a set of parameters (e.g. Time On Target, Line Rate, TDI level, etc…).

KOPSAT2 was launched successfully on the 28th of July 2006. To date, the payload is fully operating, transmitting high quality images to the Korean Ground Station (KGS) with virtually no Bit-Error Rate (BER). No need for the redundant components was yet realized.

---

[1] 'Remote-Sensing & Detectors', Optronic Technologies Dir., RD&E Division, Elop
Tel: 972-8-983-6332, Fax#: : 972- 8-930-7600, e-mail: michael.berger@elop.co.il
,. [11] Head, 'Satellite Optics Technology Dept,', Korea Aerospace Research Institute
Tel: 82-42-860-2426, Fax#: : 82-42-860-2603, e-mail: shlee@kari.re.kr
,. [111] Dir., 'Satellite Application Center', Korea Aerospace Research Institute
Tel: 82-42-860-2003, Fax#:: 82-42-860-2828, e-mail: phy@kari.re.kr

DETECTION AND THREE DIMENSIONAL MAPPING OF FAST MOVING OBJECTS

Yaniv Leitner, Ram Oron and Vladi Palatnik

KiloLambda Technologies, Ltd.
22a Raoul Wallenberg, P.O.B. 58089, Tel-Aviv 61580
yaniv@kilolambda.com www.kilolambda.com

Detecting fast moving objects is challenging. Even more challenging is accurately locating them in space. Optical sensors have a few basic advantages over RF sensors: they are far more immune to jamming and electromagnetic noise; and due to the shorter wavelength, their spatial resolution can be significantly better. Thus, they are excellent candidates for accurate 3-dimensional mapping.
Based on several source-detector pairs, we introduce optical sensors that can locate fast moving objects that penetrate into a virtual optical screen. This 3-dimensional mapping is based on combinations of range measurements, triangulation and geometry.
The sensors can optically detect objects from distances ranging from a few centimeters to several meters. Additional properties are clutter and sun rejection. These are obtained using signal modulation, fast switching of sources and smart signal processing. Also, robust design allows for operation in extreme environmental conditions.
We will present several sensor configurations, including sensitive detection schemes which allow for improved signal to noise ratios. Such custom-made sensors are available for various applications.

THE EFFECT OF PARTICLES SIZE DISTRIBUTION IN DUST CLOUDS ON THEIR MEASURED SIGNATURE IN THE IR SPECTRAL BAND

Eyal Agassi[a], Ayala Ronen[a], Eitan Hirsch[b]
[a]Israel Institute for Biology Research;
[b]Life Science Research Israel
P.O. Box 19, Nes Ziona, 74100 Israel
agassi@iibr.gov.il

Classification of dust clouds is important considering both their potential health effects and their influence on the environment. Optical remote sensing is one of the most efficient and widely employed techniques which are applied in order to accomplish this task. However, discrimination between dust clouds which is based on their scattering properties must take into account the influence of the particulates size distribution and their shape of the measured spectrum. In this paper we demonstrate the effect of size distribution on the measured IR spectral signature of Arizona dust in different distributions. The experimental results show a significant change in the acquired spectral signature in absence of small particulates. These results are compared to computational model predictions of the spectral signatures under various parameters. The practical application of the experimental findings and theoretical analysis is discussed.

OPTICAL REMOTE SENSOR FOR GASES BASED ON POROUS SILICON NANO-STRUCTURES

Dani Hak and Shlomo Ruschin
Tel Aviv University, School of Electrical Engineering
Email: dani.hak@gmail.com

We present a nano-scale gas sensor based on periodical layer of porous silicon forming a Bragg reflector or micro-cavity. The sensor is a passive device, interrogated and analyzed by a remote unit containing a light source and spectral analyzer. It is organically sensitized for the detection of specific gases. The device can be used in LIDAR and wireless sensor network (WSN) systems.

Porous silicon (pSi) is a form of the chemical element silicon which has an extremely large surface to volume ratio. It is usually manufactured by etching away most of a layer of silicon using wet electro-chemical etches. What is left is a finely connected network of sub micrometer silicon threads. These sponges-like structures suck up gas through capillary condensation. Due to the large surface to volume ratio they can be used as efficient and highly sensitive sensors. The optical properties of such devices depend on the pore diameter. Therefore, the reflection spectrum of such devices can be engineered by controlling the porosity by means of the current in the electro-chemical etching process. The manufacturing process is low cost and takes several minutes. Bragg reflectors at various peek wavelengths were manufactured from single crystal silicon. The overall thickness of the active layer stacks is of about 2um. In the reported experiments, the pores were filled with a chemical indicator that is sensitive to PH. The reflection spectrum was measured by means of a compact spectrometer used for metrology. These devices showed strong and fast response to ammonia in low concentrations. Moreover, they show fast return time to base state and were reusable. Such devices are appropriate to act as smart dust and in a LIDAR system, since they can be made very small and lightweight. Typical applications include industrial and military environment monitoring of hazardous materials. The method is extremely versatile since its specificity is determined by the indicator added into the pores.